Rhabdopleura by differences probably ordinal in value, and which in some of its characters and in general appearance resembles the ordinary Phylactolæmata.

It is unnecessary to insist on the interest that must attach to such a form should it exist. I trust that this notice may meet the eye of some one who may have the opportunity of searching the locality from which my father's specimen was obtained, and to whom the point to be solved may appear of sufficient importance to warrant a thorough investigation.

XXV.—*The Sponge-fauna of Norway; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. Sollas, M.A., F.G.S., &c.

[Continued from p. 144.]

[Plates X., XI., XII.]

Order TETRACTINELLIDA, Marshall.

Tribe **PACHYTRAGIDA**, Carter.

Group *Geodina*, Carter (Family *Geodiidæ*, O. Schmidt).

Genus 1. Geodia, Lmk. Type *G. gibberosa*, Lmk.
(*Pyxitis*, Sdt.)

2. Cydonium, Fleming. Type *C. zetlandicum*, Johnst.
(*Geodia*, auct.)

3. Pachymatisma, Bwk. Type *P. Johnstoni*, Bwk.

4. Caminus, Sdt. Type *C. Vulcani*, Sdt.

5. Placospongia, Gray. Type *P. melobesioides*, Gray.

The sponges belonging to the group Geodina have been known to naturalists for nearly two centuries, though for the greater part of this time they were lost in that chaotic assemblage which formed the genus *Alcyonium*. It was in 1815 that Lamarck* defined, under the name of *Geodia*, the first genus of the Geodine group; but so powerful a hold had the imaginary Alcyonian character of these sponges upon the minds of the zoologists of those days, that even after the generic distinctness of *Geodia* was perceived it was still retained,

* Mém. du Mus. d'Hist. Nat. i. p. 333, 1815.

even by Lamarck himself, in close connexion with *Alcyonium*, and was regarded as a member of the same family. Lamarck's description of his genus is as follows :—" Polyparium liberum carnosum tuberiforme intùs cavum et vacuum, in sicco durum; externâ superficie undiquè porosâ. Foramina poris majora, in areâ unicâ orbiculari et laterali acervata." On page 334 (*loc. cit.*) he concludes his observations with the remark, " . . . . la forme d'une géode close et la facette orbiculaire, et en crible que l'on observe sur les Géodies, constituent leur caractère générique." A single species, *Geodia gibberosa*, Lamk., is given as the type.

In 1828 Fleming * took from the *Alcyonia* another Geodine genus, and gave it the name of *Cydonium*. His definition is thus given :—" A coriaceous skin, internally carneous, with numerous straight-ridged spicula perpendicular to the surface; polypi with a central opening, and an orifice at the base of each of the eight pinnated tentacles." His type is given as *Cydonium Mülleri* (*A. cydonium*, Müll. Zool. Dan. t. 81. f. 3, 4, 5, *a*, and Jameson, Wern. Mem. i. p. 563). In his observations he states that the skin consists of animal matter cementing innumerable siliceous grains, and that the spicules, which are collected in bundles and radiate from the centre, become in many cases trifid or tricuspidate immediately under the skin.

Nothing could be clearer from this description than the fact that Fleming had before him a genus of genuine Geodine sponge. There can be no doubt about this; but if there were it would be immediately dispelled by a reference to the figure given by Bowerbank † of Fleming's original type, which is a typical *Geodia zetlandica*, Johnston.

It is remarkable that Fleming should have attached to this sponge the characters of an Alcyonian polype; nor can it be explained by easily-made references to the vigorous imaginations of the early naturalists; it seems more likely that the explanation may be of the following nature. The spicular characters of *Cydonium* Fleming had observed for himself; the Alcyonian characters he could not have observed, because they did not exist; but he identified his sponge with *Alcyonium cydonium* in Müller's Zool. Dan. (*loc. cit.*), which, from Müller's clear and apparently faithful drawings, is evidently a true *Alcyonium*. Fleming next proceeded to add the characters of Müller's specimen to those of his own, and thus produced the curious hybrid we find in *Cydonium Mülleri*. Such cases of mistaken identification are not, I believe, altogether

* British Animals, p. 516.

† Bowerbank, 'British Sponges,' iii.

unknown at the present day. Nor was Fleming wholly to blame for this blunder; for his type specimen was handed to him by Prof. Jameson *, who had previously erroneously identified it with Müller's *Alcyonium cydonium*. Müller further contributed his share to the confusion, as appears from the following remarks by Montagu †:—"Müller has also figured what he considers the Linnæan *Alcyonium cydonium* (Zool. Dan. iii. tab. 81); but this is clearly an *Alcyonium* bearing innumerable polypi; and we cannot, therefore, think it is the same as the *Alcyonium cotoneum* of Pallas, which may be the Linnæan *Cydonium*, and is probably a *Spongia*" ‡.

But, apart from this curious mistake of Fleming's, one fact stands out in the clearest manner; and that is, the marked distinction which separates Fleming's genus *Cydonium* from Lamarck's genus *Geodia*. Both were regarded by their authors as allied to *Alcyonium*; but while Lamarck's was characterized by a depressed cribriform area and a hollow cavity within, Fleming's was carneous internally and with a few congregated oscules on the exterior. Had Fleming's genus possessed the same characters as Lamarck's, the name *Cydonium* might have been cancelled; as it is, the two genera are independent of each other, and the names *Geodia* and *Cydonium* must be equally retained. Fleming's specific description is altogether inadequate, and the appellation *Mülleri* has no more value than a MS. name; it must therefore yield to that attached to the first adequate description; and this certainly is *zetlandica*, Johnston.

In 1834 Blainville § adopted with hesitation Fleming's genus *Cydonium*, though, with his usual inaccuracy, he assigned it to Jameson. He placed it, as its describer's definition necessitated, close to *Alcyonium*. Blainville also adopted Lamarck's genus *Geodia*; but this he placed with the sponges (Amorphozoa), as Deshayes and Milne-Edwards like-

* Mem. Wern. Soc. i. p. 563, 1811. † Ibid. ii. p. 117, 1818.

‡ [The clear-sighted Montagu was quite right; the *Alcyonium cotoneum* of Pallas and the *Alcyonium cydonium* of Linné are names given to the Geodine sponge so admirably figured by Donati, on whom Linné conferred the well-deserved epithet "OCULATUS Donati." Of this sponge Donati figures, 1750 (!), the external facies, exhibiting the hollow in which would lie the great cribriform oscule (an admirable section), and the spicula in their proper position and separately. The crust of globates, the dermal porrected spicula, the porrecto- and patento-ternates which support the crust, and the acerates of the body of the sponge are all excellently drawn. The minute stellates the microscope of those days would not reveal; but there cannot be a doubt that Donati's sponge, which is Linné's *Alcyonium cydonium*, is most closely related to *Cydonium zetlandicum*.—Rev. A. M. NORMAN.]

§ Man. d'Act. pp. 525, 534.

wise did in a note to the genus in their edition of the Anim. s. Vert. of 1836.

In 1842 Johnston* redescribed Fleming's specimen of *Cydonium Mülleri*, and, not recognizing the distinction between *Cydonium* and *Geodia*, placed it in the latter genus with the specific name *zetlandica*.

In 1862 Bowerbank † reconstructed the genus *Geodia*, taking as the basis for his characterization *Geodia Barretti*, Bwk., which, as it happens, possesses the specially Lamarckian character of numerous oscules congregated in a deeply depressed area, though Bowerbank makes no mention of this fact in his generic definition. Through this omission, and the fact that *G. Barretti*, Bwk., is solid and not hollow within, there is nothing in the character of Bowerbank's *Geodia* to distinguish it from *Cydonium*, if we choose to disregard, as we must, the fictitious Alcyonian characters which Fleming erroneously added to his definition of *Cydonium*.

In the same year (1862) Oscar Schmidt ‡ also defined afresh the Lamarckian genus *Geodia*, and, by leaving out the characters which Lamarck expressly stated were typical of his genus, caused it to include the *Cydonium* of Fleming. Schmidt described four new species, all of which appear to be true *Cydonia*. He also described (p. 43 *loc. cit.*) a new genus of *Geodiidæ* under the name of *Caminus*. It differs from *Cydonium* (*Geodia*, Sdt.) in the absence of trifid spicules, and of a needle-down covering the rind, and also by the presence of a single large osculum.

In 1864 Duchassaing de Fonbressin and Gio. Michelotti § published a description with admirable illustrations of the type species of Lamarck, *Geodia gibberosa*; they also described and figured an allied species, *Geodia cariboa*, D. & M.

In 1866 Bowerbank‖, having examined Fleming's type specimens, enters into a long discussion respecting the conflicting claims of the names *Cydonium* and *Geodia*. I quote his summing up :—“The history of this sponge (*Geodia zetlandica*) presents a singular sequence of errors. In the first place, Müller is distinctly wrong in the designation of his species, which undoubtedly is *Alcyonium* of Ray and Linnæus. Prof. Jameson, perhaps misled by the stellate mantlings on the surface, believed the sponge from ‘Fullah and Unst’ to be the same as Müller's specimen and an *Alcyonium*. Dr.

* Hist. of Brit. Sponges, p. 195.
† Phil. Trans. p. 1098.
‡ D. Spongien d. Adriat. Meeres, p. 49.
§ Spongiaires de la Mer Caraïbe, p. 104, pl. xxv. figs. 2, 8.
‖ Monograph Brit. Sponges, ii. p. 50.

Fleming, at the time of the publication of his 'British Animals,' appears to believe it to be not an *Alcyonium*, but still identical with Müller's specimen, and accordingly gives it both a new generic and specific name. At last Johnston, seeing that it is not the type of a new genus, sinks both Dr. Fleming's generic and specific names, and, correctly assigning the specimen to *Geodia*, renames it *zetlandica*."

In 1866 * Oscar Schmidt, in discussing the synonymy of Bowerbank's genera, expressed his doubts as to the position of *Geodia M'Andrewi*, Bwk., and stated that it might perhaps be a *Caminus*. He adopts Bowerbank's genus *Pachymatisma*, and suggests that *Geodia*, Bwk., is equivalent to *Geodia*, Sdt., *plus* (with a query) *Caminus*, Sdt.

In 1867 Dr. Gray †, for the first time since its institution, asserted the claims of Fleming's genus to an independent existence. Earlier in the year Dr. Gray had described and figured a new and curious Geodine sponge in which the cortex is divided into a number of distinct plates, and which possesses a central axis of globate spicules. This he made the basis of a new genus, *Placospongia*, and, indeed, of a whole new family, the *Placospongiadæ*. Dr. Gray's arrangement of the Geodine sponges is as follows:—

Fam. 1. **Geodiadæ.**

Genus 1. PACHYMATISMA, Bwk. *P. Johnstoni*, Bwk.

2. GEODIA, Lmk. *G. gibberosa*, Lmk.

3. CYDONIUM, Fleming. *C. Barretti*, Bwk.

4. ERYLUS, Gray. *E. mammillaris*, Sdt.

5. TRIATE, Gray. *T. discophora*, Sdt.

6. CAMINUS, Sdt. *C. Vulcani*, Sdt.

Fam. 2. **Placospongiadæ.**

Genus 1. PLACOSPONGIA, Gray. *P. melobesioides*, Gray.

In 1868 Bowerbank ‡ commented on Dr. Gray's reinstatement of Fleming's genus as follows:—"Dr. Fleming describes his genus as having polypi with a central opening and an orifice at the base of each of the eight pinnated tentacles, showing either that he had greatly mistaken the nature of

* Zweites Suppl. d. Spong. d. adriat. Meeres, p. 11.
† Proc. Zool. Soc. 1867, pp. 127, 492.
‡ Proc. Zool. Soc. 1868, p. 131.

G. zetlandica, Johnst., or that he had described the orange-coloured variety of *A. digitatum*, Johnst. (Brit. Zooph. ed. 2, vol. i. p. 174). *The latter appears the most probable.*" The italics are mine; and it is scarcely conceivable that Bowerbank can have written this after what he said in 1866, and after an examination of Fleming's type specimens, which he then stated were *Geodia zetlandica*. It will be observed also that Bowerbank says nothing here of the presence of the trifid spicules and globates, which Fleming mentions as occurring in his *Cydonium*, and which by themselves are sufficient to prove that Fleming can have had no other than a Geodine sponge before him.

In 1869 Carter * described a new species of *Cydonium* as *Geodia* (*Cydonium*, Gray) *arabica*; and he added afterwards that his *G. arabica*, being closely allied to *G. zetlandica*, appears under Dr. Gray's third genus, viz. that termed "*Cydonium*."

In 1870 O. Schmidt † gave an account of the characters of the Geodinidæ, added some remarks on the genus *Geodia*, Sdt., and established a new genus, *Pyxitis*. This new genus is characterized by the occurrence in most of its members of a large body-cavity, and in all by the localization of a pore-area for the outflowing water-currents—the very characters seized upon by Lamarck as typical of his *Geodia*! But, worse than this, Lamarck's type *Geodia gibberosa* is appropriated by Schmidt as the type of his genus *Pyxitis*. It is certain that this kind of nomenclature will never be tolerated by impartial naturalists. A genus may be subdivided any number of times that may be necessary; but it is always understood that that subdivision which retains the type species shall also retain the original name ‡. If Schmidt thought it necessary to distinguish those Geodine sponges in which "durch Localisirung eines Porenfeldes für die Ausströmung so bestimmt &c.," from others in which such is not the case, he might, with some show of justice, have given a new name to the latter, but certainly not to the former, which belong inalienably to Lamarck's genus *Geodia*. This distinction, made by Schmidt in 1870, existed, however, in our nomenclature as early as the year 1828, the date of Fleming's genus, and was again distinctly enforced by Gray in 1867, three years prior to Schmidt's publication of it. Yet Schmidt, who, when Nardo is in question, is such a champion of priority, calmly ignores the observations of both his predecessors and pro-

* Ann. & Mag. Nat. Hist. ser. 4, vol. iv. p. 4, pl. i. figs. 9–16.
† Spong. Fauna d. atlantischen Gebietes, p. 68.
‡ See Rule § 4 of the Stricklandian Code.

ceeds, without altering the essential characters of Lamarck's genus, to give it a new name. No wonder that complaints of an overburdened nomenclature are becoming chronic!

In the years 1872–74 numerous descriptions of new species belonging to the genera *Cydonium*, *Geodia*, and *Pachymatisma*, accompanied by beautiful drawings, were published by Bowerbank *.

In 1874 likewise appeared the 3rd vol. of Bowerbank's 'British Sponges,' containing a fine figure of that typical specimen of *Geodia zetlandica* which had previously been examined and described by Fleming and Johnston.

In 1873 Grube † described and figured a specimen of *Pachymatisma Johnstoni*, Bwk., under the name of *Caminus osculosus*. It came from the coast of St. Malo.

In 1876 ‡ Carter described, with many interesting observations, two new species of *Geodia*—one with cribriform depressions (*G. nodastrella*), and the other with a single vent (*G. megastrella*).

The table given at the commencement of this paper represents the classification as it at present stands. The genera appear to me to require fresh examination and revision; but this is a subject to which I hope on a future occasion to recur.

Geodia Barretti, Bwk. §

The specimen under description differs only in trifling details from *Geodia Barretti*, and must necessarily be included in that species.

In form it is almost spherical, 1 inch in diameter, free, with a small Halichondroid sponge attached to it, the surface of attachment measuring $\frac{1}{4}$ inch square. It possesses a single circular oscule (Pl. X. fig. 3) $\frac{1}{16}$ inch in diameter, situated in the centre of a low dome-shaped elevation, 0·15 inch in diameter, which rises from a shallow annular depression. The surface is smooth except for the protrusion of a few long fusiform acerate spicules at one or two particular spots, and of a large number of minute acerates generally, which render it finely hispid.

The spicules (see figures on Pl. XI.) do not differ in character from those already described by Bowerbank; but it may be as well to call attention to the great length of the shafts of

* Proc. Zool. Soc. 1872–74.

† Mittheil. ü. St. Malo u. Roscoff &c. p. 132, Taf. 2. figs. 3, 3 *a–e*.

‡ Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. p. 397, pl. xvi. figs. 45–47.

§ Phil. Trans. 1862, pl. xxxii. fig. 2; Hist. Brit. Sponges, i. 1864, p. 167, pl. xxviii. fig. 354; and Proc. Zool. Soc. 1872, p. 198, pl. xi.

the slender porrecto- and recurvo-ternate spicules (Pl. XI. figs. 8, 9, and 16), as these are not completely represented in Bowerbank's illustrations. In addition to the cylindro-stellates mentioned by Bowerbank there are also present in the mark a number of sharp-rayed forms, of which an instance is represented in Pl. XI. fig. 20. The cylindro-stellates of the mark often attain a much larger size than those of the cortex, which are exceedingly minute.

The arrangement of the spicules has also been excellently described by Bowerbank, so that I need now only call attention to the distribution of the stellates. The cylindro-stellates are confined to the rind and the mark immediately surrounding the crypts, the sharp-pointed forms commence immediately below the crypts, and are found throughout the rest of the mark. They never occur in the rind. This distribution is identical with that existing in *Stelletta Normani*, and probably in most Pachytragous sponges possessing two varieties of stellates.

The Canal-system.—The single oscule opens into a cylindrical tube with a rounded termination (Pl. X. fig. 1); it is 0·15 inch long and 0·1 inch wide; its walls are smooth, but rendered finely hispid by the projecting ends of small acerate spicules, which cannot be seen with the naked eye. Ending against the apparently imperforate walls of this tube, two canals are seen in a transverse section of the sponge; they are 0·1 inch wide, and descend from the oscular tube in a curved direction more or less concentric with the outer surface of the sponge. Although only these two tubes are shown in a single transverse section, there can be no doubt that others exist and would be revealed by fresh sections taken in different directions. The interior of these large excurrent tubes or main trunks of the excurrent system (for such they are) has a smooth glistening surface, which is concentrically striated by fine circular ridges and furrows, reminding one in general appearance of the "valvulæ conniventes" of the small intestine, though of course they are of very diminutive size (Pl. X. fig. 2, *r*). Similar folds, but possibly not quite so regular, exist in Mr. Carter's sponge *Axos spinipoculum*, and have suggested the same comparison to him (Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pl. xxv. figs. 4, 5, p. 287). A number of sharply defined circular openings are seen in the walls of the excurrent trunks, the commencement of secondary canals which proceed from them and branch repeatedly in the substance of the sponge.

Under a low-power magnification and by reflected light the oscular tube exhibits two or three small circular openings,

which place it in free communication with the excurrent trunks. These visible openings, however, are but one or two out of a great number unseen, and which are not seen because they are closed by sphincters; they can readily be made out, however, in sections by transmitted light.

We shall recur to them in describing the histology of the sponge in detail; it is sufficient to state now that the excurrent trunks, which break up into small canals in the interior of the sponge, communicate with the oscular tube by means of sphincters, and thus can be shut off from or put into communication with the exterior as circumstances may determine. The incurrent canals can best be studied in thin sections (Pl. X. fig. 6, and Pl. XII. fig. 34); the pores of the dermis lead into chones, which open each by a sphincter into the subcortical crypts; from the floor of each crypt a cylindrical tube of sharply defined outline (Pl. X. fig. 6, *i*, and Pl. XII. fig. 34) extends downwards for a variable distance into the mark, and, branching below like a bronchus, ends in fine canaliculi. Its walls are more or less finely perforated by openings from which minute canaliculi proceed. Lying parallel with these incurrent tubes and between them are others of a different character; they are generally wider, less regular in form, with more widely perforated walls, and are occasionally traversed by an irregular trabecular network (Pl. X. fig. 6, *e*, and Pl. XII. fig. 34). From the perforations in their walls canals proceed, which, after branching once or twice, and sometimes anastomosing, end in fine canaliculi. The position of these excurrent tubes with respect to the incurrent tubes is inverse; *i. e.* their open extremity is turned towards the centre of the sponge, their more or less closed end towards the rind, while the incurrent tubes lie with the closed end towards the centre and the open end towards and in free communication with the crypts. The floors of the crypts open into narrow short canaliculi like those proceeding from the incurrent canals; and in both cases these fine canaliculi open, somewhat abruptly, into ciliated chambers, the outflow-canals from which constitute the canaliculi of the excurrent tubes. These excurrent tubes, the primary twigs of the branched excurrent system, communicate with larger canals, which run concentrically with the exterior surface of the sponge (Pl. X. fig. 6, *c*). From these concentric canals other canals with trabecular walls proceed and extend deeper into the mark (Pl. X. fig. 6, *e′*), branching till they end in fine canaliculi. These canaliculi end in ciliated chambers, which are connected by shorter canaliculi with other tubes resembling in general character the primary incurrent canals. At first sight the representation of the canal-system

shown in figure 6 gives one the idea that the canals marked e' are distributive and not collective in function, in which case the water, which had already passed from the incurrent into the excurrent canals, would be again distributed through a fresh set of ciliated chambers, and thus be used twice over. This does not appear probable. The tubes e' have all the characters of excurrent tubes—widely perforated trabecular walls with dichotomous canals opening into them; while the tubes i' are equally incurrent in character and give off canaliculi, which enter the ciliated chambers in the abrupt fashion so characteristic of incurrent canaliculi. To complete our representation of the canal-system we must therefore suppose that the incurrent canals i'' are connected in a roundabout way by concealed canals with the subcortical crypts. By this supposition a double using of the incurrent water is avoided. In the centre of the sponge one observes sections of canals cut across in every possible direction; but even here the distinctive characters of the excurrent and incurrent canals, as described above, appear to be maintained.

The general course of the water-circulation of the sponge would appear to be as follows:—The water finds access through the dermal pores or ostia to the chones, whence it finds it way into the subcortical crypts and the incurrent canals; from these it is distributed by multitudinous little canals to the ciliated chambers, the seat of the energy on which the working of the water-circulation depends. From these chambers it passes out by fine canaliculi, which, after uniting together once or twice or oftener, empty themselves into the trabecular excurrent tubes; from these the water flows unobstructed into the large excurrent vessels, which deliver it through sphinctral apertures into the oscular tube, whence it passes freely to the exterior.

Histology.

1. *The Cortex.*—The exterior of the sponge is covered by a thin membranous film, immediately beneath which is a single layer of minute cells (Pl. XII. fig. 26), each containing a minute cylindro-stellate spicule, and having an average diameter of from 0·0002 to 0·0003 inch. The superficial membrane appears to be a mere secretion of the underlying cells, and with them forms the epidermis of the sponge (Pl. XII. fig. 26, *e*).

The epidermis is succeeded by a layer of curious tissue (Pl. XII. fig. 26, *c*), which presents a striking but superficial resemblance to the parenchymatous tissue of plants. It consists of an irregular network of very refringent, faintly bluish,

transparent, narrow trabeculæ, enclosing clear transparent cavities, each of which is provided with a round nucleus and nucleolus lying on the side of one of the trabeculæ (Pl. XII. fig. 24). This is its character in its most completely specialized state; when less specialized its constituent cells can be easily made out (Pl. XII. fig. 25, *a* to *e*). They are 0·001 inch in diameter, of a round, oval, or irregularly polygonal form, and consist of an outer thick hyaline thread-like border or cell-wall, enclosing a large clear vacuole, and a small quantity of finely granular colourless sarcode, in which is imbedded a round nucleus with its nucleolus. They appear to be produced by the metamorphosis of the ordinary protoplasmic cells of the mark, and, by the fusion of their outer borders where these touch one another, give rise to the parenchyma-like tissue just described, to which the name of "vacuolated connective tissue" may be applied. The layer which this tissue forms beneath the epidermis is of variable thickness, on an average from 0·002 to 0·003 inch; it is distinguished by the entire absence of cylindro-stellate or other spicules, the only spicules which occur in it being the small fusiform acerates, which penetrate at one end the subjacent globate layer, and project at the other beyond the surface of the sponge. It may be as well to give this layer of tissue a distinct name; and though the term "dermis" is not altogether free from objection in its application here, it has, at least, the merit of convenience.

The next layer of the cortex, 0·01 inch thick, is that of the globate spicules (Pl. XI. fig. 7, *c*). The characters of these have most of them been already described by other observers. It is a fact, however, worthy of special mention, that some of these spicules contain within a well-marked pit-like hilum a distinct oval nucleus with a spherical nucleolus.

The globates do not lie loosely aggregated together, but are regularly conjoined by short thick fibrillated ligaments. The ligaments pass directly from the side of one globate to the opposed face of its nearest neighbour; and since in the plane of a single transverse section one globate may be seen surrounded by five or six others, so there will also be seen five or six ligaments proceeding from it, like the spokes of a wheel, one for each of its surrounding fellows. As the surrounding globates are also joined to each other by ligaments, so a number of triangles are produced, having the ligaments for their sides and a globate lying on each angle. The centre of the triangle, which is left vacant by the ligaments, is occupied by a cell or cells, which, with their nuclei and nucleoli, exactly resemble one of the vacuolated cells of the dermal

layer. The attachment of the fibres of the ligament is provided by the tubercles of the globate; and when a globate is torn out from the cortex it carries its ligaments with it, as a hair-like coating of radiating fibres.

The fibres are exceeding fine threads, mere lines in thickness, and consist of altered protoplasm, which stains but very slightly with carmine. Small refringent granules occur amongst them; and in places they appear to pass into the fibres of the succeeding cortical layer (Pl. XI. fig. 7, *f*). This, which in describing *Stelletta Normani* (Sollas) we called the muscular layer, is comparatively thin, varying from 0·0015 to 0·0035 inch in thickness. It consists of fibres similar to those of *S. Normani*, arranged in variously oriented fasciæ, in a layer which is closely opposed to the inferior face of the globate layer; intermingled with the fibres are a considerable number of vacuolated connective-tissue cells, which are frequently aggregated together in groups, and sometimes form a distinct stratum on the lower face of the muscular layer, which, most exteriorly, is always covered by an epithelial membrane with associated cylindro-stellates. The trifid heads of the ternate spicules which appear to support the cortex are also imbedded in the muscular layer, the fusiform fibres generally surrounding the spicular rays concentrically. This arrangement is shown on the left-hand side of the endochone in fig. 7 (Pl. XI.).

2. *The Chones.*—The ectochone of the cortical layer has generally the form of an inverted bell, covered by a thin dermal layer above and closed by a muscular sphincter below. From its upper and outer angle canals extend themselves horizontally into the dermis, and, widening out, give rise to a shallow dermal cavity, the roof of which is united to the floor by small columns of connective tissue. The layer of tissue covering the ectochone and that above the dermal cavities are perforated by a number of very short tubes or ostia, which place the cavity of the chone in communication with the external medium. The endochone is a shallow dome-shaped cavity which communicates freely with the subcortical crypt. The surface of the chone and its canals is continuously lined throughout with an epithelial membrane containing numerous cylindro-stellate spicules. The roof of the chone consists of fine fibrous tissue lined below with the stellate-bearing epithelium, which is continued over the sides of the ostia into the layer of epidermis which covers the roof of the chone above (Pl. XII. fig. 33). The fibres of the chonal roof surround the ostia sphinctrally. The ectochone, when it lies in the globate layer, is surrounded by vesicular connective tissue, while the

walls of the endochone consist almost entirely of muscular tissue. From the various states in which the endochone occurs in different cases, sometimes almost entirely obliterated by the closure of its muscular walls, sometimes continuous in one and the same straight line by the widely open state of the intervening sphincter, one may infer that it behaves as a part of the sphinctral muscle: when the upper portion alone of this muscle contracts we have the condition of things represented in Pl. XI. fig. 7; when the whole contracts, that represented in Pl. XII. fig. 30, where the endochone has become constricted to a mere narrow tube; while, should the sphincter remain altogether relaxed, we have the form shown in Pl. XI. fig. 23.

The muscular fibres of this sphincter have here, as in *Stelletta Normani*, a character very different from that of the other fusiform fibres of the cortex; the axial threads are much thicker, the hyaline exterior is reduced in quantity, and the whole muscle has a less transparent and much greyer appearance than in the other case. Moreover the fibres of the lower face of the cortex do not stain deeply with carmine, while those of the sphincters acquire an intense colour with this tinction-reagent. Finally, the latter are so arranged that they can and evidently do contract, and thus are true muscles both by function and structure; while the former occur in such places and arranged in such a manner that it is difficult to understand how, in this sponge at least, they could contract, or what purpose i would serve if they did. Thus, altogether, I begin to doubt how far it is justifiable to extend our ideas as to the nature of the sphinctral fibres to those of the lower cortex, and am much more inclined to regard the latter as forming a kind of fibrous connective tissue, and the former alone as true muscles.

Before leaving the subject of the chones it would be but fair to the memory of Bowerbank to bear our testimony to the striking fidelity which characterizes his representation of the structure of these organs—a fidelity which is the more striking when we consider the comparatively small size which they possess in this species, and recollect the imperfect methods which this much-abused observer had at his disposal.

3. *The Subcortical Crypts.*—Compared with those of *Stelletta Normani*, the crypts beneath the general surface of the sponge are of very trifling dimensions; but beneath the surface which gives attachment to an adhering foreign sponge they become abnormally large, attaining a length four or five times that of the average. This probably is a pathological peculiarity due to the disturbance of the normal water-circula-

tion, produced by the probably commensal parasite. The crypts are lined by an epithelial membrane containing numerous cylindro-stellate spicules. The pillars of the crypts are traversed by the long-shafted spicules, and consist partly of mark-substance, and partly of vacuolated connective-tissue cells, which sometimes form a distinct layer beneath the epithelium (Pl. XII. fig. 27). Sometimes the mark-cells of the pillars are elongated into spindle-shaped fibres, which do not generally differ, except in shape, from ordinary mark-cells, but sometimes become hyaline and vacuolated (Pl. XI. fig. 15, *g* and *v*).

4. *The Incurrent Tubes.*—The tubes are simple excavations in the mark, lined by epithelium, which consists of a single layer of flattened cells, furnished with a round nucleus and nucleolus, but with indistinct or invisible cell-borders.

5. *The Excurrent Tubes.*—The smaller canals (Pl. XII. fig. 32) of the excurrent system do not differ from the corresponding incurrent tubes in structure; but the larger tubes have walls of a much more complex character. The large vessels, for instance, which open into the oscular tube are first lined by an epithelial membrane containing fine fibrils and round or oval nuclei with their nucleoli; beneath this follows a colourless transparent layer, which scarcely stains with carmine, and attains a thickness of 0·0007 inch. It consists of fine fibres (Pl. XI. fig. 15, *f*) of considerable length, with a swollen middle part, in which a central round granule or small nucleus may sometimes be discerned, and of vacuolated connective-tissue cells, which, when they lie immediately under the epithelium, sometimes contain a sharp-rayed stellate spicule. The rugæ of these vessels consist of an extension of the fine fibrillar layer covered by the epithelium. Globate and small acerate spicules occur in the walls of these vessels.

6. *The Oscule and Oscular Tube.*—The wall of the oscular tube below the cortex (Pl. X. fig. 2) is 0·02 inch thick, and consists for the most part of fibrous tissue, which does not stain with carmine, and is traversed by a number of small acerate spicules, which project from it erectly, and thus produce the hispid appearance of its surface previously mentioned. Vacuolated connective-tissue cells occur intermingled with fibres on both the inner and outer face of the wall; and the outermost layer consists of epithelial membrane. On the inside of the wall the epithelium is associated with minute cylindro-stellates like those of the epidermis, on the outside with larger sharp-rayed stellates like those of the mark. In places the fibrous tissue of the wall passes into true muscular

fibres, which form the sphincters already mentioned. These sphincters are well exposed by a tangential section of the oscular tube-wall; in such a section (Pl. X. fig. 4) the wall is seen to be divided into a number of polygonal areas, the boundaries of which are marked by a few globate and acerate spicules, while the greater part of the area of the polygon is occupied by one of the sphinctral muscles, which, in carmine-stained sections, have a deep red colour, strongly contrasting with the uncoloured tissue of the polygonal boundary.

In the cortex (Pl. X. fig. 5) the oscular tube is lined by epithelium bearing stellates, and overlying first a finely fibrous layer, and then a thin stratum of vacuolated connective tissue, which covers the globate-layer, here very much increased in thickness, as also is the underlying cortical fibrous layer. The roof of the oscular tube consists of a thin fibrous layer, without globates, but traversed by acerate spicules and covered by a layer of cylindro-stellates above and below.

7. *The Ciliated Chambers.*—The spherical outline of these chambers, which measure 0·001 inch in diameter, bears upon its inner surface a number of small, round, highly refringent nuclei with minute nucleoli, set at regular intervals from each other; but the outlines of complete cells cannot be made out, any more than can the cilia. A sharply marked circular aperture furnishes an abrupt passage from the interior of the chamber to the incurrent canal, on which the chambers are set, while the opening into the excurrent canal, on the other hand, appears to be much more gradual and prolonged (Pl. X. fig. 6 A, and Pl. XII. fig. 36).

8. *The Mark.*—The substance of the mark, independent of the tissues which enter into the composition of the canal-system, consists of finely granular sarcode, with large oval nuclei, containing nucleoli (Pl. XII. fig. 31) scattered throughout it. It stains with carmine, but not so intensely as its imbedded nuclei. The nuclei (Pl. XII. fig. 29), which are sometimes round as well as oval, have a well-marked double contour, 0·0002 to 0·0003 inch in diameter, and contain a clear unstained space, within which is the deeply stained round nucleolus 0·0001 inch in diameter. The mark-tissue might be taken for a "syncytium," were it not that in some cases distinct cells can be made out in it, having nuclei of precisely the same characters as those just described, and consisting of granular sarcode just like the ground-mass of the mark. These cells (Pl. XII. figs. 28, 32), 0·0008 inch in diameter, have a very faint external contour; and one can readily understand how, in a sponge not specially prepared for histological examination, the borders of such cells would

become altogether undistinguishable in the majority of cases, and so, by a deceitful appearance of confluence, give rise to the notion of a syncytium. Connective tissue like that of the medusoid disk is not discoverable in this sponge; in *Thenea Wallichii*, Wright, however, the greater mass of the mark consists of it.

9. *The Spicules.*—The long-shafted spicules are enveloped in a sheath which somewhat resembles the epithelial membrane, and are accompanied by longitudinally arranged fibres like those of the cortex; they are also frequently closely surrounded by concentric fibres of a very simple appearance, consisting merely of thin flat fusiform hyaline strips with a small round central granule or nucleus.

The globates of the cortex are all full-grown forms; but those dispersed through the mark are to be met with in all stages of development. In their earliest state they consist of minute trichites, radiately arranged to form a sphere, the centre of which is either empty or occupied by some transparent substance like that of the axial thread of a long-shafted spicule. The outer ends of the trichites penetrate a thick double-contoured cell-wall, which is at first transparent and almost colourless (Pl. XII. fig. 37). On one side of this cell-wall is imbedded an oval nucleus, which strikingly resembles the nuclei of the mark-cells. With growth a deposit of silica is formed about the inner ends of the trichites, cementing them together into a transparent siliceous globule; the outer diverging ends remain unenveloped, and are easily detached from the central sphere. A hilum is for some time absent; but presently the growth of the trichites beneath the nucleus becomes slow compared with that outside it (Pl. XI. fig. 18), and as a result a conical cavity is left under the nucleus and forms the hilum of the adult spicule. The nucleus, when viewed face on, appears to rest, like a biconvex lens, over the upper end of the hilum; but a lateral view presents it as completely filling the cavity of the hilum. The cell-wall enlarges with the growth of the globate, and very early acquires a very granular appearance and a deep grey colour; it then stains deeply with carmine. Probably the preceding statement should in one point be reversed, and we should say that the trichites increase in length with the growth of the cell-wall. Finally the trichites become thicker and acquire rounded conical ends, which at length assume the characteristic adult form.

It is singular that no immature forms are met with in the cortex; and this leads one to infer that the fully-grown globate travels in some manner unknown from the mark to the lower

face of the cortex, where its dense sarcodic coating becomes metamorphosed into fibrous ligaments; only in some such manner as this can the additional globates needed for the increased area of the cortex, consequent on the growth of the sponge, be explained. It is, moreover, suggested by the fact that in embryonic *Geodiæ* the globates are at first absent in the cortex, and make their earliest appearance within the mark.

The stellate spicules, as we have already stated, are produced within the interior of cells; they may frequently be observed within a cell resembling one of the vacuolated connective cells, with transparent sarcode filling up the angles between their rays (Pl. XI. fig. 22).

Classification.—It may be thought singular to refer to *Geodia* a sponge which apparently possesses neither the cribriform oscular area nor the large body-cavity which characterize that genus. But it is to be recollected that we have been describing a young specimen, the structure of which is in all respects so similar to that of *Geodia Barretti* that no one could refuse to refer it to that species, and, next, that, according to Bowerbank's descriptions, *Geodia Barretti* clearly belongs to the genus to which we have assigned it; for, setting aside the absence of a large body-cavity, which is not really essential to *Geodia*, we have the genuine *Geodia* character displayed by Bowerbank's specimens in the possession of a large cribriform oscular area. In our sponge this area is represented by the walls of the oscular tube, which may, with growth, become a mere shallow depression, or may enlarge, as Bowerbank's descriptions show, into a cavity as much as two inches in depth.

Locality. Kors Fiord, Station No. 23. Depth 180 fathoms.

EXPLANATION OF THE PLATES.

Plate X.

Fig. 1. The cut face of a young specimen of *Geodia Barretti* divided longitudinally through the oscular tube (nat. size).

Fig. 2. Transverse section through the wall of the oscular tube below the cortex: *s*, sphincters; *e*, excurrent vessel, cut across obliquely; *r*, rugæ of its walls ($\times$ 11).

Fig. 3. Upper surface of the sponge, showing the single oscule at the summit (nat. size).

Fig. 4. Tangential section through the wall of the oscular tube, showing sphincters, *s*, in the middle of polygonal areas ($\times$ 11).

Fig. 5. Transverse section, showing one side of the oscular tube in the cortex, the greatly thickened globate-layer, and the thin dermal roof ($\times$ 11).

Fig. 6. Transverse section through the mark and cortex, showing the arrangement of the water-canals: *ch, ch*, chones; *cr*, crypts;

i, incurrent tube; *e*, excurrent tube; *c*, concentric canals; *e'*, a deeper-seated excurrent tube; *i'*, a deeper-seated incurrent tube (× 24).

Fig. 6 A. Ciliated chambers in longitudinal optical section and from a view face on (× 435).

PLATE XI.

Fig. 7. Section through the cortex, showing the structure of the chone and the ligamentous connexions of the globates (*c*): *f*, the fibrous layer (× 104).

Figs. 8, 9. Porrecto- and recurvo-ternate spicules with long slender shafts.

Fig. 10. Fusiform acerate spicule.

Fig. 11. Bifurcated ternate spicule.

Fig. 12. Globate spicule.

Fig. 13. Small acerate from the cortex.

Fig. 14. Small ternate from the upper angle of one of the crypts. Figs. 8–14 all magnified 21 diameters.

Fig. 15. Fusiform fibres of different kinds: *g*, granular mark-cell from pillar of a crypt; *v*, vacuolated cell from same place; *s*, axial thread of a muscle-fibre from a sphincter; *f*, fibres from the wall of one of the large excurrent tubes (× 435).

Fig. 16. Porrecto-ternate spicule (× 21).

Fig. 17. Cylindro-stellate from the mark (× 315).

Fig. 18. Globate spicule, showing the nucleus at one side (× 435).

Fig. 19. Young globate as seen in Canada balsam (× 435).

Fig. 20. Stellate with sharp-pointed rays, from the mark (× 315).

Fig. 21. Cylindro-stellate from the epidermis (× 435).

Fig. 22. Stellate-cell with its contained spicule (× 435).

Fig. 23. Section of a chone with widely opened sphincter (× 30).

PLATE XII.

Fig. 24. Vacuolate connective tissue from the dermis (× 435).

Fig. 25. An unaltered mark-cell occurring associated with vacuolated connective-tissue cells: *a–e*, various stages in the development of these cells (× 435).

Fig. 26. Section across the outer part of the cortex, showing—*e*, epidermis and *c*, dermis, resting upon the globate-layer.

Fig. 27. Wall of a crypt, taken from one of its upper corners, showing epithelium overlying a layer of vacuolate connective-tissue cells (× 217).

Fig. 28. A typical mark-cell, showing nucleus and nucleolus imbedded in fine granular sarcode (× 435).

Fig. 29. Nuclei which occur dispersed through the granular substance of the mark (× 435).

Fig. 30. Section of a chone, showing obliteration of endochone through the contraction of its muscular walls (× 26).

Fig. 31. A trabecula of one of the excurrent canals, to show the general character of its constituent mark-substance (× 435).

Fig. 32. A transverse section through a small canal in the mark; the surrounding mark-cells are distinguished by faintly defined outlines (× 435).

Fig. 33. A transverse section through a dermal ostium, showing stellate-bearing external layer and central fibrous layer (× 217).

Fig. 34. Section through cortex and mark, in which the incurrent canals

are more characteristically represented than in Pl. X. fig. 6 (× 30).

Fig. 35. One of the fusiform fibres that are sometimes found lying longitudinally upon the side of a small acerate spicule (× 435).

Fig. 36. Section along an incurrent canal lying in the middle of the mark, showing ciliated chambers and the small outflow-tubes leading towards an excurrent canal (× 140).

Fig. 37. A very early form of globate spicule, from a preparation in glycerine (× 435).

[To be continued.]

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

January 21, 1880.—Henry Clifton Sorby, Esq., LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "On the Genus *Pleuracanthus*, Agass., including the Genera *Orthacanthus*, Agass. & Goldf., *Diplodus*, Agass., and *Xenacanthus*, Beyr." By J. W. Davis, Esq., F.G.S.

The author commenced with an historical account of the supposed genera of fishes founded on remains occurring in Carboniferous and Permian strata, mentioned in the title of his paper. The teeth described by Agassiz under the name of *Diplodus* have been already shown by Sir Philip Egerton to be associated with spines of the *Pleuracanthus* type; and this identification was accepted by the author, who also showed that *Xenacanthus*, Beyrich, is identical with *Pleuracanthus*, and that, on the ground of priority, which there is no reason for disregarding, the latter name ought to be retained. With regard to *Orthacanthus*, he indicated that in the type described by Agassiz the two rows of denticles are placed close together along the posterior face of the spine, while in his *Pleuracanthus* the denticles are situated as far as possible apart on the sides of the spine. In the new Carboniferous species described in the present paper, and in those described and figured by the officers of the United-States Survey, the denticles occupy almost every intermediate position between these two extremes; and hence the author was inclined to unite *Orthacanthus* with *Pleuracanthus*. *Compsacanthus*, Newb., is also probably nearly related to *Pleuracanthus*. The author described in some detail the characters of the genus *Pleuracanthus*, and discussed its scientific position, with regard to which he inclined to the adoption of Dr. Rudolph Kner's opinion that the Pleuracanths constitute a type of fish intermediate between the Elasmobranch and Teleostean fishes, but more nearly approaching the latter, probably through the Siluroids.